DERIVING GREATER VALUE FROM IOT BY COMBINING EDGE AND OPERATIONAL DATA
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Keywords
Digital Transformation, Unstructured Data, Time-series Data, Cloud Analytics, Edge Analytics, Industry 4.0, Industrial IoT (IIoT), Maana

Cloud to Edge Pendulum

For industrial companies engaged in digital transformation, analytics are key to turning large volumes of data into business value for operational enhancements as well as improved customer experience. Facing intense financial pressure and competition in rapidly changing global markets, these companies need to think very carefully about where that data is and how best to leverage it.

In some instances, data and analytics need to be processed centrally, such as in a cloud, to drive strategic decisions. In other situations, operational decisions will need to be made instantaneously, meaning that centralized solutions cannot provide the analysis.

Decentralized analytics, otherwise known as “edge” analytics or computing, occur at or near the edge of the operational network. They are quite common in some consumer-facing industries, particularly those with highly mobile customers, such as retail, communications, and finance. However, until recently, analytics at the industrial edge wasn’t possible due to a mix of cost, complexity, security, and technology barriers.

That is changing. Digitization is occurring in all industrial environments. In brownfield infrastructure, intelligence is being added via devices such as sensors and gateways. In new infrastructure, we’re seeing intelligence added through embedded software and preconfigured equipment.
As this change has taken place, ARC has observed the market focus swinging away from centralized Big Data and analytics toward edge data management and analytics. This makes sense to some degree, as the growth of edge IoT devices and related data has skyrocketed and will continue to do so.

However, edge analytics that rely too heavily on data generated only by equipment and devices overlook some of the most valuable data and insight available to industrial companies: operational data, a portion of which is also generated at, or near, the operational edge; plus process knowledge.

**Cloud and Edge Redefine Analytics**

In industrial settings, there has long been a hierarchical structure of data, connection to it, and communication of it across an organization. Operations personnel, whether in a field environment or on the plant floor, can certainly attest to processes and technology designed to capture, share, and use the data. Yet, limits on the use of the data were considerable, constrained rather tightly at times by business siloes and technology.

This data structure precedes the Internet. As the Internet becomes a ubiquitous part of business and operating environments, this traditional data structure is being replaced.

Organizations are now beginning to see the value of a more comprehensive view of data and analysis. This improved view includes centralized processing, such as in the cloud (or even on premises on a server), and extends seamlessly to and from the operational edge.

**Cloud Emerges**

Cloud computing is a modern approach for developing and deploying software applications and services. The cloud is gradually displacing the older client/server model, in which large, complex, monolithic applications were created and run. As business leaders wrestle with the “data explosion,” they see cloud computing as the solution for associated volume, speed, and complexity issues.
The cloud can bring massive computational power to solve problems since it provides a viable solution for combining complex and large data sets - both structured and unstructured - with advanced analytics techniques.

Examples include applying machine learning to acoustics data to predict asset failure, integrating text analysis for process optimization, or using image analysis for product assurance.

**Edge Gets Defined**

In reaction to the growth of the cloud, the concept of the “edge” of an organization has been defined as the farthest extensions of a businesses operating environment, whether physical infrastructure, distributed operational points, or customer engagements.

Edge analytics extends data processing and computing close to or at the data sources, which include equipment and devices. In industrial operations, analytics executed at the edge typically support tactical use cases for efficiency, reliability, unplanned downtime, safety, and customer experience.

In industrial settings, examples of equipment-based data sources can include edge machines such as robots, fleet vehicles, and distributed microgrids. Devices might include meters, control stacks, small single-board computers, sensors, and network gateways.

Most edge data from these sources are noise, in that they typically have limited or no value to the organization. Edge analytics can help determine what data are helpful and extricate immediate value from them. By identifying what data are useful, they can also act as a filter for information that gets sent to the cloud for additional analysis.

**Elements Often Overlooked in IIoT**

When thinking about the data for edge analytics, a common misperception is that they only consist of streaming data, time stamped based on the input source. They are often referred to as Industrial Internet of Things (IIoT) data. The thinking here is that a combination of connection, automation, and edge analysis, and workflow automation are key to getting value from the data.
While true, this only paints a portion of the picture within the context of IIoT strategies. What’s missing, is an understanding of the value of operational processes and their related data, some of which may be generated at the edge. Because these data are often generated and captured by subject matter experts (SME), they typically contain high-value information.

A good IIoT analytics strategy accounts for a broad set of operational data and knowledge, from records in maintenance and enterprise resource planning (ERP) system to valuable notes and images generated by field service personnel, for example.

**Operational Data**

Operational data, particularly those generated at the edge, are often underutilized, if used at all. Unless a formal process exists, these data are rarely ”systemized” into a source that can make them available as part of the overall pool of operational data. Images, videos, and notes captured and shared during events (and then forgotten) are examples.

These often reflect observations of the most experienced workers or insights from the most valuable and loyal customers. They can include crucial information that can only be gained during events, provide critical information on best practices associated with optimized operations, or deliver direct input about product functionality and customer satisfaction.

The nature of edge operational data often means there is a high correlation with streaming, time-stamped data generated in parallel by equipment and sensors.

**Process Knowledge**

In addition to operational data, SMEs understand (and often design) operational processes and best practices. These high-value workers have specific knowledge of how to operate equipment, execute maintenance, and ensure safety procedures. For example, crude oil engineers have expertise around the impact of crude types on equipment failure during the refining process. This intellectual property is invaluable, of course, and organizations are fearful it will leave the business as workers retire or move on.

Technologies are now available that can mathematically model and capture that expertise as part of the analytics. In doing so, this process knowledge can be augmented with operational and IIoT data. This blending of
knowledge and data can be used to drive the optimized decisions flows and equipment performance necessary for maximizing IIoT strategies.

**Blending Data and Knowledge Maximizes IIoT Value**

Leveraging a broad set of operational data (including from the edge), equipment (IIoT) data, and worker expertise ensures the accuracy and value of analytics. Examples include:

- Weather observations noted in inspection reports from an engineer correlate to timestamp data, indicating issues such as unexpected dust in a wind turbine, high level of salt on oil platforms, or unexpected pump failure. Maintenance manuals can be used to further automate maintenance execution. Financial data can provide a view into the risk of action or inaction.

- Pictures taken during engine maintenance on a vessel by certain crews correspond to future anomalies in asset performance, pinpointing differences in work execution among field personnel. Notes in work orders identify steps taken during maintenance by individual crews, showing process errors versus accepted best practices. Rework percentages and cost of crew metrics point out which third-party resources are ineffective.

- Expert observations recorded about aroma or taste during a food product quality control inspection correlate to air measurements made in a production area. Social media complaints also indicate that the changes are causing quality assurance issues. Analysis uncovers the correlation among these sources, improving consistency across process and plants.

**A Knowledge Framework Makes the Blend Usable**

Organizations that wish to unlock the value of the correlations amongst all these blended operational and IIoT data and subject matter expertise will need to apply context to them. Certainly, advanced analytics can determine patterns, identify trends, and pinpoint anomalies. However, without subject matter experts to provide the context needed to make these findings useful for operations, these findings would remain within the realm of data scientists.
Another benefit of applying a knowledge framework to operational and IoT data and their correlations is that the analytics can be dynamically incorporated into decision making.

Bringing SMEs into the analytics process delivers the context that is key to turn data into insight. The role of a SME is to build a knowledge framework. The framework determines at a high level the problem being solved; variables to consider; relationships between inputs; structure for decision flows; and processes, metrics, and stakeholders impacted.

With SMEs involved, the knowledge framework has the necessary context for what the data means and how, where, when, and why insights should be applied. The analytics then populates it with operational and IIoT data, turning the framework into a usable decision model.

Another benefit of applying a knowledge framework to IoT and operational data is that the analytics can be dynamically updated. With the knowledge framework in place, many types of data can be fed continuously into the analysis. As updates are made and new correlations discovered, those insights inform the knowledge structure, so an organization can continuously make the best possible decisions.

**Industrial Companies Combine IoT and Operational Data for Strategic Benefit**

Some of the world’s largest industrial companies—Chevron, GE, Maersk, and Shell—use analysis that combines the power of centralized processing and the integration of sensor and all types of operational data, all brought together by a knowledge framework. According to Maana, a company that specializes in digital knowledge, these companies are reaping a broad range of benefits, particularly related to profitability, and are achieving them much faster than anticipated. Use case examples include:

- **Reducing annual cost of equipment repairs by $300 million for processing crude oil by predicting factors leading to corrosion.**

  Previously siloed operational data, from chemical composition and demographics to work and sensors, were combined into analysis. The solution enabled crude engineers at this company to quickly access risk profiles, mitigation strategies, and optimal processing practices based on dynamic knowledge of more than 200 oil types and onsite conditions.
• Reducing safety, security, and environmental risk at oil and gas sites.

By incorporating a broad range of operational data, such as onsite safety reports and external safety documentation with well sensor data, this company built a dynamic and searchable risk application. Based on their roles, supervisors, field workers, and engineers could then query insight, best practices, and recommendations as needed. This was particularly useful in minimizing risk for those with limited site knowledge.

The above use cases and results are being delivered through Maana’s Knowledge Platform using its patented knowledge graph, a wide range of analytics techniques that integrate streaming and operational data (including from the edge), artificial intelligence, machine learning, and semantic search.

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